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VITAL GUIDE SERIES 12

The basic principles of dental implants

- History and evolution.
- Dental implant definitions.
- Implant treatments and maintenance.

VITAL GUIDE TO Dental implants

Jack Mirza* and **Guy Robertson**** outline the origin of dental implants and how they are used today, with case studies and treatment protocols.

Background

Mankind has been troubled by tooth loss for over 5,000 years and has since been trying to develop different ways to replace missing teeth. Early history reveals evidence of various materials and types of implants being placed into the human jaw. Most of these were predominantly unsuccessful in the long term. It was not until the mid 1950s that a chance discovery allowed a substantial leap forward in the development of dental implants. Professor Per-Ingvar Brånemark of Sweden, an orthopaedic surgeon, was studying the blood flow characteristics in rabbit bone. To visualise the blood vessels, he placed a titanium chamber within the rabbit bone. At the end of the experiments he wanted to remove these titanium chambers but noticed that he could not as they were firmly integrated to the bone. This caught his attention and, with further research, he found that commercially pure titanium allowed bone to grow in close contact with it. He later defined this phenomenon as 'osseointegration'.

Dental implants

The vast majority of dental implants can be simply defined as a titanium screw that is placed within the jaw bone allowing a crown, bridge or denture to be attached to it. Early implants used in the mid-twentieth century came in a variety of shapes. These varied from implant frameworks that rested in direct contact with the bone beneath the soft tissues, to blade shaped implants that were placed within the alveolar bone (Fig. 1). The use of these implants systems had not been thoroughly researched, and the eventual outcome was often infection and loss of the implants.

Modern implants are commonly cylindrically shaped, and are usually screwed into a pre-prepared site within the maxillary or mandibular bone (Fig. 2).

A. This is the main body of the implant termed the 'fixture'. It is usually made of titanium. The surface of an implant fixture is in direct contact with the bone and will determine the biological response. If unfavourable, osseointegration will not occur and the implant will fail. Some implant surfaces include gold, zirconium and titanium-vanadium-vandium alloys but by far the most researched and successful surface is commercially pure titanium. A tough and relatively inert oxide layer forms quickly on its surface when exposed to air. This surface is biocompatible and allows bone to form in close contact with it.

Commercially pure titanium surfaces may be modified by a variety of methods such as sand-blasting, acid-etching, or coating its surface to improve osseointegration. More recent implant systems incorporate chemicals which can stimulate bone growth, such as bone morphogenic proteins.

B. This is the top of the implant fixture termed the 'implant fixture head'. Restorations are attached to this part of the implant.

C. This is the crown (restoration) that has been attached to the fixture head.

Placing an implant

There is a large variety of components available to complement the great number of different implant systems on the market today. The following is a basic introduction to the different stages of implant placement and to some of the standard components that may be universal to most implant systems.

As with any dental treatment, a comprehensive medical, dental, and social history is an essential part of the treatment planning. Any conditions or factors, such as smoking, that may affect the successful outcome of the treatment should be identified. This is then followed by a thorough extra- and intra-oral examination.

When planning to treat an edentulous area, whether it is a single missing tooth or multiple missing teeth, a series of investigations (study casts, wax-ups, plain film radiographs, and CT scans) may need to be carried out. The most important aims of these investigations are to evaluate bone volume, quality, and morphology and thus suitability for implant placement.

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Fig. 1 Views of blade implant

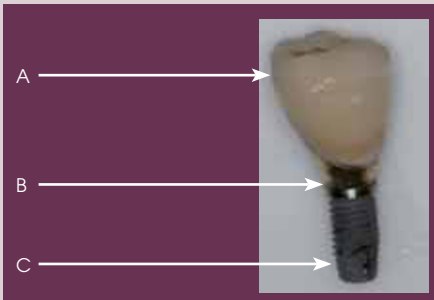
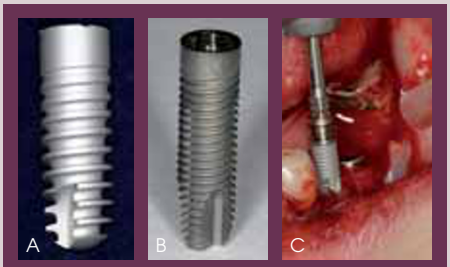


Fig. 2 Restored dental implant



Figs 3a-b Views of implant fixture
Fig. 3c View of fixture being inserted in bone

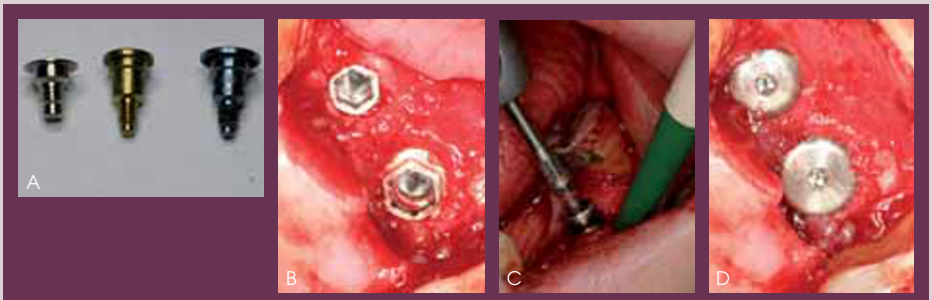


Fig. 4a Variety of cover screws. Fig. 4b Implant fixtures in bone without cover screws. Fig. 4c Cover screw being screwed onto implant fixture. Fig. 4d Cover screws on implant fixture

Fig. 5 Incision in mucoperiosteum

First stage

The *First stage* of placing an implant can be carried out under local anaesthetic, sedation, or general anaesthetic. An incision is made in the soft tissues, exposing the bone. A sequence of drills is used to prepare a hole within the bone that corresponds to the size and shape of the particular implant being used. Surgical acrylic stents may be used to guide the clinician where to place the implant.

The implant body or fixture (Fig. 3) is the titanium screw that is placed within the prepared site (osteotomy) in the bone.

When following a traditional two-stage procedure, a cover screw is usually immediately screwed on to the head of the implant to protect it from bone or soft tissue growing onto and into it (Fig. 4). The soft tissues are then sutured together covering the implant fixture and the cover screw.

Second stage surgery

After a period of healing (commonly ranging between six months in the maxilla and three months in the mandible), the *Second stage surgery* is performed. The implant is exposed through a small incision in the mucoperiosteum allowing access to the cover screw (Fig. 5).

The cover screw is removed and replaced by a 'healing abutment'. The healing abutment pierces through the soft tissues and is exposed within the oral cavity, allowing the soft tissues to heal around it (Fig. 6). This period is commonly four to six weeks but may vary depending on the healing of the soft tissues.

Once the soft tissues have healed a variety of alternatives are available. To make a fixture head impression the healing abutment is removed and an impression coping is then screwed onto the implant head and a silicone impression is taken (Fig. 7). The impression is then sent to the dental technician, who will manufacture the restoration.

Whilst the restoration is being manufactured the healing abutment is screwed back onto the implant head.

If a temporary restoration is made it will be manufactured on temporary components, such as temporary cylinders (Fig. 8).

Permanent restorations may be screw retained directly to the implant fixture head or via an intermediary component known as an 'abutment'. Restorations or abutments may be either screw retained using prosthetic screws (Fig. 9) or cement retained (Fig. 10).

Abutments may be manufactured (straight or angled) or custom-made (Fig. 10) for the individual.

Indications for dental implants

Dental implants may be used to replace single or multiple missing teeth. They can also be used in conjunction with removable dentures to help retain and stabilise them.

Clinical examples

Case 1

A 55-year-old healthy female presented complaining that her upper removable partial denture was loose, causing her embarrassment. Examination revealed that she was missing the maxillary six front teeth (Fig. 11).

She had adequate bone, making it possible to restore the missing teeth with an implant-retained fixed bridge. This allowed the patient to have six upper front teeth fixed to the implants, giving her confidence and optimum aesthetics and comfort.

Fig. 6a Healing abutment. Fig. 6b-c Examples of healing abutments attached to implant fixtures

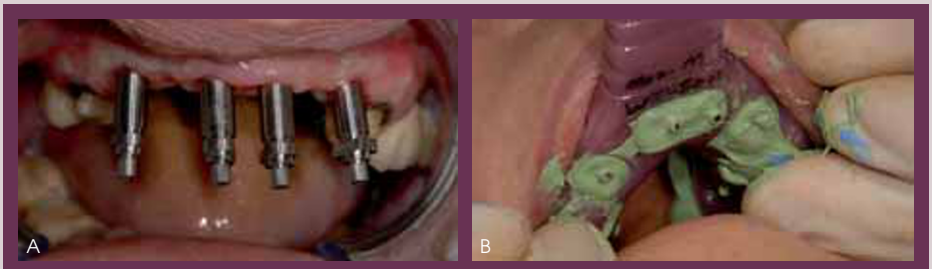


Fig. 7a 'Impression copings' attached to implant fixtures. Fig. 7b Silicone impression of 'impression copings', taken using the 'open-tray' method

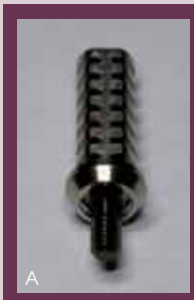


Fig. 8a Temporary cylinder. Fig. 8b Temporary acrylic crown made on temporary cylinder

Fig. 9 Examples of prosthetic screws

Fig. 10a Custom abutments screwed onto implant fixture. Figs 10b-c Restoration to be cemented onto the custom abutments

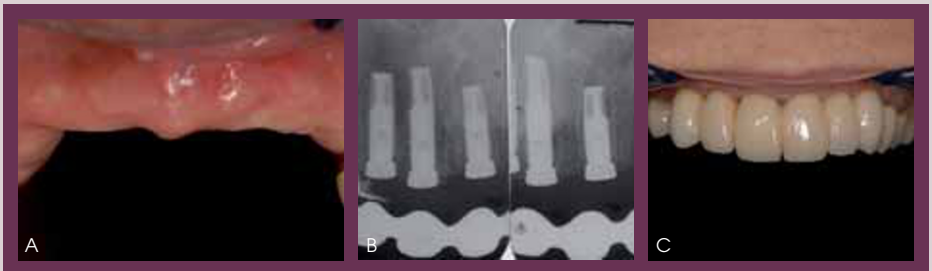


Fig. 11a Edentulous anterior maxilla. Fig. 11b Radiograph of implant fixtures and temporary bridge Fig. 11c Permanent anterior fixed implant retained bridge replacing the six upper anterior teeth

Case 2

A 60-year-old healthy male presented complaining that his lower complete removable denture was loose. Detailed clinical and radiographic examination revealed inadequate volume of bone; this meant that only three implants could be placed without any further surgical procedures, such as bone grafting. An implant-retained over-denture would help retain and support his denture, giving him more confidence (Fig. 12).

Treatment protocols

A wide range of treatment protocols that may vary from the original Brånemark approach are in use today. These include planning fixtures at the same time as tooth extraction (*Immediate placement*). *Immediate loading* involves placing restorations very shortly after the implant is placed. *One stage* surgery involves placing healing abutments or other transmucosal elements at the same time as implant placement. Computer aided planning of implant surgery using software manipulation of three dimensional radiographs is now possible.

Success rates of implants

Quoted success rates vary between 95 and 98% in the first five years following placement. Implants fail for a variety of reasons. Some medical conditions may predispose to higher failure rates, such as uncontrolled diabetes, or immunosuppressive states. Implant over-loading, poor oral hygiene and smoking remain amongst the commonest contributors to implant failure. Regular check-ups with the dentist and maintenance with the dental hygienist are of paramount importance.

Maintenance of implants

Following successful osseointegration, careful maintenance of the implant is essential to ensure long term success. This involves giving the patient instructions on how to clean around the implant, using aids such as interdental brushes, floss, single tufted toothbrushes and Chlorhexidene gel (Fig. 13). Regular visits to the hygienist are helpful and the hygienist should be careful not to scratch the fixture surface. Teflon-coated or plastic scalers may be used, and ultra-sonic scalers should be avoided.

Conclusion

Since the mid 1960s dental implants have evolved and are now a predictable treatment option with a success rate of about 95-98%. They have revolutionised tooth replacement, improving patients' quality of life, allowing situations that could previously only be treated

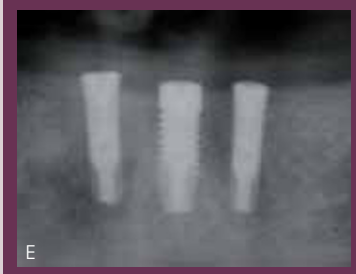


Fig. 12a Edentulous mandibular ridge. Fig. 12b Surgical area with osteotomy sites prepared. Fig. 12c Implant fixtures and cover screws in place. Fig. 12d Soft tissues sutured together. Fig. 12e Radiograph of implant fixtures. Fig. 12f Healing abutments in place. Fig. 12g Impression copings screwed onto implant fixtures. Fig. 12h Final restoration, a gold bar screwed onto the implant fixtures. Fig. 12i Clips in the denture, which will attach to the gold bar when the denture is placed in the mouth. Fig. 12j The over-denture in place, attached to the gold bar

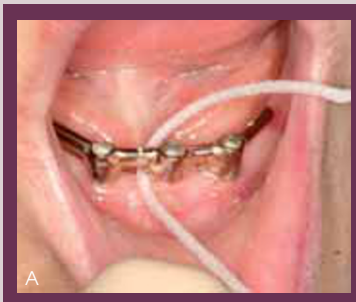


Fig. 13a Floss around a gold bar. Fig. 13b Interdental brushes. Fig. 13c Single tufted toothbrushes. Fig. 13d Floss underneath an implant bridge

with removable dentures or bridges to be now restored with the use of implant supported fixed restorations.

Dental implants are an essential part of the dentist's armamentarium and it is essential that all members of the dental team are familiar with the basic principles.

Relevant articles

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CPD questions on this article can be found on page 54.